STATEMENT OF WORK
TITLE: "Carbon Fabric Stitch Development"

1. INTRODUCTION/BACKGROUND

NASA is investigating the development of woven carbon fabrics for implementation in deployable aeroshells used in entry, descent and landing. The carbon fabric and the joints between fabric panels need to withstand the harsh aero-thermodynamic and aerodynamic loading environments imparted by high speed entries into planetary atmospheres. One of the key challenges facing the development of deployable aeroshells constructed from carbon cloth is the joining of gore sections to close-out the aeroshell structure and to interface with underlying rigid structural elements. In the deployed state, it is expected that the carbon fabric will be under substantial tensile loads (up to 300 lbf/in), and during hypersonic flight, aerodynamic loading could increase the tensile loading in the fabric to 650 lbf/in. It is essential that the stitching used to join gore sections be capable of maintaining integrity at high temperature (~ 3500 F), which suggests that carbon fiber threads will be needed. It is also important that multilayer fabrics can be stitched in incremental layers, so that failure of the top layer does not compromise the entire stack. However, stitching with carbon thread is challenging, as the handling and stress involved in the stitching process tends to adversely affect its structural properties, leading to low seam strength.

2. SCOPE OF WORK/OBJECTIVES

Developing reliable stitch methods would be a major contribution for the successful development of deployable aeroshells composed of carbon fabrics (thickness ranging from 0.05-0.20 inch). There are numerous parameters to investigate, including but not limited to thread type, seam type, stitch pattern/density, and sewing process variables. Evaluating the various stitch designs through load testing (performed by NASA), combined structural and aerothermal loading, and component interface tests should provide candidate designs to carry further along in the development process.

NASA may award one or more fixed price non-commercial purchase orders for this developmental effort. The total value of the awarded purchase orders is not expected to exceed $100,000. Vendors shall provide a firm fixed price to perform Task 3.1 and a firm fixed price to perform Option Task 3.2.

3 TASK DESCRIPTIONS

3.1 Carbon Thread Stitching Design Trade Study (Task 3.1)

This study will investigate the feasibility of joining samples of woven carbon fabric using carbon fiber based sewing threads. Batches of small-scale carbon fabric samples (~3 inch wide by 9 inch length) possessing the required design features will be evaluated and structural assessment parameters identified. Load testing of the various stitch and seam design concepts should lead to the identification of the key design parameters to further investigate. The outcome of this study will be the downselect of a primary and alternate stitch and seam design to carry forward for further testing and development.

Milestones

3.1.1 Kick-off meeting with NASA (within 1 month after purchase order award) to define fabric features to be used, the set of stitch patterns for preliminary assessment, and the dimensions of stitched coupons for load testing. NASA will define the metrics for ranking alternate designs.

3.1.2 (1 month after receiving NASA provided carbon fabric samples) Contractor shall provide preliminary results for 5 candidate stitch designs, and a summary report on difficulties encountered and progress achieved. Contractor shall provide 3 load test samples for each candidate stitch design.

3.1.3 (1 month after downselect decision [after NASA load tests samples]) The contractor shall provide 10 test samples for each of 2 downselected stitch designs.

The period of performance for this task will be six months, commencing upon purchase order award.

3.2 Stitch Scalability and Testing Development (Option Task 3.2)

If exercised, the goal of Task 3.2 is to investigate longer seams derived from the primary and alternate stitch designs identified in Task 3.1. The carbon fabric samples provided for this task will be representative of structural and aerothermal test models that will be used to evaluate the performance of the stitches in environments representative of flight. In addition, the identification of the key stitch design parameters along with test and evaluation methods found suitable to assess structural design quality will be identified.

Milestones

3.2.1 Contractor shall produce samples of seams that are no more than 2 m long, with 10 layers “incrementally” stitched. (2 samples for each of 2 stitch patterns).

3.2.2 Contractor shall deliver a Final Data Package (FDP) and report that includes scalability considerations (in thickness and seam length, infrastructure required, special tooling) and challenges anticipated to achieve desired test article design. The final report shall include estimation of maximum seam strength (as % of strength of woven fabric) and notes on handling and environment restrictions for the seams.

The period of performance for Task 3.2 will be six months, commencing upon exercise of Option Task 3.2.

4 DELIVERABLES

4.1 Period of Performance

The period of performance is expected to not exceed 15 months for the entire effort (Tasks 3.1 and 3.2, if exercised).

4.2 Final Data Deliverable

The Final Data Package (FDP) for each task will be delivered to NASA within thirty (30) days after task completion. The FDP will include an executive summary, nomenclature, test article photographs, and the design study data on electronic media.

5 GOVERNMENT FURNISHED INFORMATION/PROPERTY

NASA will provide the carbon fabric articles for design, test and evaluation of various stitch designs. The carbon fabric samples will be approximately 3” wide by 9” long.

6 TESTING

After delivery of the stitch design samples, NASA will conduct a series of tests to characterize the ultimate tensile strength of various carbon fabric weaves and fabric samples that are joined together with various stitch designs. Characterizing the tensile properties will aid in the optimization of the aeroshell design. This test series will aid in the downselect of stitch designs to pursue for further development. NASA will retain rights to the stitch designs developed under these purchase orders, and they may be shared with other contractors and utilized in future development efforts. All NASA structural test data obtained from a vendor’s stitching samples will be shared with the vendor.